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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<b>(54) Title: PROCESS FOR MAKING LOW DENSITY FOAMS, POLYOL COMPOSITION AND REACTION SYSTEM USEFUL THEREFOR</b> <b>(54) Titre: PROCESSUS DE FABRICATION DE MOUSSES DE FAIBLE DENSITE, COMPOSITION AU POLYOL ET SYSTEME DE REACTION A CET EFFET</b>		
<b>(57) Abstract</b> <p>The invention relates to a polyol composition comprising by weight 60-97 % of b1) a polyoxyethylene-polyoxypropylene polyol, having a functionality of 2-6 with 10-25 % tipped EO; 3-40 % of b2) a polyoxyethylene-polyoxypropylene polyol, having a functionality of 2-6, with 20-50 % total EO and 10-20 % tipped EO; and 0-25 % of b3) a polyol, having a functionality of 2-6, with at least 50 % random EO. The invention also relates to a process for preparing a flexible polyurethane foam by reacting a) a polyisocyanate composition; b) a polyol composition of the invention; c) water; and d) additives and auxiliaries known per se. The invention finally relates to a reaction system comprising A) a polyisocyanate and B) an isocyanate-reactive component comprising the polyol of the invention.</p> <b>(57) Abrégé</b> <p>Cette invention concerne une composition au polyol, qui comprend en masse 60 à 97 % b1) d'un polyoxyéthylène-polyoxypropylène polyol, ayant une fonctionnalité de 2 à 6 avec 10 à 25 % d'EO d'extrémité de chaîne; 3 à 40 % en masse b2) d'un polyoxyéthylène-polyoxypropylène polyol, ayant une fonctionnalité de 2 à 6, avec 20 à 50 % d'EO total et 10 à 20 % d'EO d'extrémité de chaîne; 0 à 25 % en masse b3) d'un polyol, ayant une fonctionnalité de 2 à 6, avec au moins 50 % d'EO aléatoire. Cette invention concerne aussi un processus de confection d'une mousse de polyuréthane souple que l'on obtient en faisant réagir a) une composition polyisocyanate; b) une composition au polyol de l'invention; c) de l'eau; et d) des additifs et des agents auxiliaires connus per se. Cette invention concerne enfin un système de réaction qui comprend A) un polyisocyanate et B) un composant réagissant aux isocyanates comprenant le polyol de l'invention.</p>		

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(54) Title: PROCESS FOR MAKING LOW DENSITY FOAMS, POLYOL COMPOSITION AND REACTION SYSTEM USE-  
FUL THEREFOR

(57) Abstract: The invention relates to a polyol composition comprising by weight 60-97 % of b1) a polyoxyethylene-polyoxypropy-  
lene polyol, having a functionality of 2-6 with 10-25 % tipped EO; 3-40 % of b2) a polyoxyethylene-polyoxypropylene polyol, having  
a functionality of 2-6, with 20-50 % total EO and 10-20 % tipped EO; and 0-25 % of b3) a polyol, having a functionality of 2-6,  
with at least 50 % random EO. The invention also relates to a process for preparing a flexible polyurethane foam by reacting a)  
a polyisocyanate composition; b) a polyol composition of the invention; c) water; and d) additives and auxiliaries known per se. The  
invention finally relates to a reaction system comprising A) a polyisocyanate and B) an isocyanate-reactive component comprising  
the polyol of the invention.

**Description**

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PROCESS FOR MAKING LOW DENSITY FOAMS, POLYOL COMPOSITION  
AND REACTION SYSTEM USEFUL THEREFOR

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5 The instant invention relates to a process for making low density foams. It also relates to a specific polyol composition and to a reaction system that are useful in the said process.

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10 For flexible polyurethane foams, low density means cost effectiveness. Thus, low density is a target, that should however not be obtained with detrimental effects on the foam properties. Physical blowing, using carbon dioxide for example, is known to reduce foam density, but is associated with processing difficulties as well as the need for additional equipment.

20

15 US-P-5 686 502 discloses foams obtained through a one-shot process, where the polyol comprises a first polyol which is a poly(oxyalkylene)triol which is chain terminated with oxypropylene (PO) and a second polyol which is either (i) a poly(oxyalkylene)diol terminated with EO, or (ii) a polyfunctional polyol terminated with PO. The thus obtained foams are hydrophylic. The densities obtained in the examples vary between 13 and 20 kg/m<sup>3</sup>. There is no mention of the resilience.

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25 which are prepared by reacting a specific polyol composition. The polyol composition comprises a block PO/EO polyol having an OH value of 14 to 65, 2 to 9 % of tipped EO and a functionality of 2.3 to 2.8 and a di- or tri-functional PO/EO polyol having an OH value of 20 to 80 and 60 to 85 % of EO (preferably up to 20 % as tipped EO). The resulting foams are visco-elastic and do not exhibit any ball rebound (for densities obtained in the examples of about 70-77 kg/m<sup>3</sup>).

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35 US-P-4 833 176 discloses a process comprising reacting a polyisocyanate with a polyol at a NCO index below 70. The polyol may vary; examples comprise mixtures of a low EO-content polyol and high EO content polyol.

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5 EP-A-0 845 485 discloses a process for preparing flexible foams comprising reacting a polyisocyanate with a polyol, where the polyol is a specific polyol composition. Said polyol composition comprises : (i) a  
10 5 polyetherpolyol having a functionality of 2.5-6.0, which is a PO/EO polyol with 15 % or less of EO; (ii) a polyetherpolyol having a functionality of 1.8-2.5, which is an all-PO polyol; (iii) a polyetherpolyol having a  
15 functionality of 1.8-6.0 and having an EO content of at least 50 wt%. The respective amounts of components (i), (ii) and (iii) are as follows : (i) 15-70 %, (ii) 30-80 %, and (iii) 3-15 %, based on the combined weights of  
20 the polyols.

US-P-5 594 097 discloses a polyol comprising PO and  
15 EO, having an OH value of 16-45, a primary hydroxyl content of at least 50 %, an EO content of 21-49 %, and having a structure of the type PO-(PO/EO)-EO, where the tipped EO content is 10-20 %. This specific polyol is said to be usable in combination with other polyols. All  
20 examples, however, relate to polyol compositions comprised solely of this specific polyol. Also, while a relatively low density is obtained, (i) there is no disclosure of the resilience values and (ii) there are processing difficulties and bad compression set when the  
30 EO-enriched polyol is used as the main polyol.

35 None of the above documents teaches or suggests the instant invention.

The following way of describing polyols is used in the present application : A PO-EO polyol is a polyol  
40 30 having first a PO block attached to the initiator followed by an EO block. A PO-PO/EO polyol is a polyol having first a PO block and then a block of randomly distributed PO and EO. A PO-PO/EO-EO polyol is a polyol  
45 having first a PO block then a block of randomly distributed PO and EO and then a block of EO. A PO-EO  
35 polyol is a polyol having first a PO block and then an EO block. In the above descriptions only one tail of a  
50

5 polyol is described (seen from the initiator); the nominal hydroxy functionality will determine how many of such tails will be present.

10 5 The present invention provides a process that surprisingly affords a resilient flexible polyurethane foam having a good stability (low recession) and the advantages of EO enriched polyol as the main polyol (i.e. density reduction) without having the drawbacks (i.e. negative impact on mechanical properties, like tensile strength, elongation and tear strength).

15 10 The invention thus provides a polyol composition comprising :

20 b1) a polyoxyethylene-polyoxypropylene polyol, having an average nominal hydroxyl functionality of 2-6 where the EO is present as tipped EO, the EO content being between 10-25 % by weight based on the weight of the polyol

25 b2) a polyoxyethylene-polyoxypropylene polyol, having an average nominal hydroxy functionality of 2-6, where the EO is present as tipped EO and random EO, the total EO content being between 20-50 % and the tipped EO content being between 10-20 %, both by weight based on the weight of the polyol

30 b3) a polyol, having an average nominal hydroxy functionality of 2-6, and comprising EO and optionally PO where the EO is present as random EO, the EO content being at least 50 % by weight based on the weight of the polyol

35 30 these polyols b1, b2 and b3 being present according to the following proportions, based on the combined weights of b1, b2 and b3, b1 : 60-97 wt %, b2 : 3-40 wt %, b3 : 0-25 wt %.

40 35 Unless otherwise stated amounts of EO and PO in a polyol are indicated hereinafter as % by weight based on the weight of the polyol.

50

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5           The invention thus provides a process for preparing a flexible polyurethane foam at an NCO index of 70-120 and preferably of 70-105 by reacting :

10           a) a polyisocyanate;  
5           b1) a polyoxyethylene-polyoxypropylene polyol, having an average nominal hydroxyl functionality of 2-6 where the EO is present as tipped EO, the EO content being between 10-25 %;

15           b2) a polyoxyethylene-polyoxypropylene polyol, 10 having an average nominal hydroxy functionality of 2-6, where the EO is present as tipped EO and random EO, the total EO content being between 20-50 %, the tipped EO content being between 10-20 %,

20           b3) a polyol, having an average nominal hydroxy 15 functionality of 2-6, and comprising EO and optionally PO where the EO is present as random EO, the EO content being at least 50 %,

25           these polyols b1, b2 and b3 being present according to the following proportions, based on the combined 20 weights of b1, b2 and b3, b1 : 60-97 wt %, b2 : 3-40 wt %, b3 : 0-25 wt %;

30           c) water; and

          d) additives and auxiliaries known per se.

35           The invention finally relates to a reaction system 25 comprising A) a polyisocyanate and B) an isocyanate-reactive component comprising the polyol of the invention and water, as well as to a reaction system comprising A) a polyisocyanate prepolymer obtained by reacting the 40 polyisocyanate with part of the polyol composition of the invention, and B) an isocyanate-reactive component 30 comprising the remainder of the polyol composition of the invention and water.

45           In the context of the present invention the following terms, if and whenever they are used, have the following 35 meaning :

1) isocyanate index or NCO index :

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55

the ratio of NCO-groups over isocyanate-reactive hydrogen atoms present in a formulation, given as a percentage :

$$\frac{[\text{NCO}] \times 100}{[\text{active hydrogen}]} \quad (\%)$$

In other words the NCO-index expresses the percentage of isocyanate actually used in a formulation with respect to the amount of isocyanate theoretically required for reacting with the amount of isocyanate-reactive hydrogen used in a formulation.

It should be observed that the isocyanate index as used herein is considered from the point of view of the actual foaming process involving the isocyanate ingredient and the isocyanate-reactive ingredients. Any isocyanate groups consumed in a preliminary step to produce modified polyisocyanates (including such isocyanate-derivatives referred to in the art as quasi or semi-prepolymers and prepolymers) or any active hydrogens reacted with isocyanate to produce modified polyols or polyamines, are not taken into account in the calculation of the isocyanate index. Only the free isocyanate groups and the free isocyanate-reactive hydrogens (including those of the water, if used) present at the actual foaming stage are taken into account.

2) The expression "isocyanate-reactive hydrogen atoms" as used herein for the purpose of calculating the isocyanate index refers to the total of hydroxyl and amine hydrogen atoms present in the reactive compositions in the form of polyols, polyamines and/or water; this means that for the purpose of calculating the isocyanate index at the actual foaming process one hydroxyl group is considered to comprise one reactive hydrogen, one primary or secondary amine group is considered to comprise one reactive hydrogen and one water molecule is considered to comprise two active hydrogens.

5                   3) Reaction system : a combination of components  
wherein the polyisocyanate component is kept in a  
container separate from the isocyanate-reactive  
components.

10               5           4) The expression "polyurethane foam" as used  
herein generally refers to cellular products as obtained  
by reacting polyisocyanates with isocyanate-reactive  
hydrogen containing compounds, using foaming agents, and  
15               10           in particular includes cellular products obtained with  
water as reactive foaming agent (involving a reaction of  
water with isocyanate groups yielding urea linkages and  
carbon dioxide and producing polyurea-urethane foams).

20               15           5) The term "average nominal hydroxyl  
functionality" is used herein to indicate the average  
functionality (number of hydroxyl groups per molecule) of  
the polyol composition on the assumption that this is the  
25               20           average functionality (number of active hydrogen atoms  
per molecule) of the initiator(s) used in their  
preparation although in practice it will often be  
somewhat less because of some terminal unsaturation.

30               30           6) The term "average" is used to indicate an  
average by number.  
The polyisocyanates may be selected from aliphatic,  
cycloaliphatic and araliphatic polyisocyanates,  
35               25           especially diisocyanates, like hexamethylene  
diisocyanate, isophorone diisocyanate, cyclohexane-1,4-  
diisocyanate, 4,4'-dicyclohexylmethane diisocyanate and  
m- and p-tetramethylxylylene diisocyanate, and in  
40               30           particular aromatic polyisocyanates like tolylene  
diisocyanates (TDI), phenylene diisocyanates and most  
preferably diphenylmethane diisocyanate optionally  
comprising homologues thereof having an isocyanate  
45               35           functionality of 3 or more (such diisocyanates comprising  
such homologues are known as crude MDI or polymeric MDI  
or mixtures of such crude or polymeric MDI with MDI) and  
modified variants thereof.

5           The diphenylmethane diisocyanate (MDI) used may be  
selected from 4,4'-MDI, 2,4'-MDI, isomeric mixtures of  
4,4'-MDI and 2,4'-MDI and less than 10% by weight of  
10           5   2,2'-MDI, and modified variants thereof containing  
carbodiimide, uretonimine, isocyanurate, urethane,  
allophanate, urea and/or biuret groups. Preferred are  
4,4'-MDI, isomeric mixtures of 4,4'-MDI and 2,4'-MDI and  
15           10 less than 10% by weight of 2,2'-MDI and uretonimine and/or  
carbodiimide modified MDI having an NCO content of at  
least 20% by weight and preferably at least 25% by weight  
and urethane modified MDI obtained by reacting excess MDI  
20           and polyol having a molecular weight of at most 1000 and  
having an NCO content of at least 20% by weight and  
preferably at least 25% by weight.

15           15       Diphenylmethane diisocyanate comprising homologues  
having an isocyanate functionality of 3 or more are so-  
25           called polymeric or crude MDI.

20           20       Polymeric or crude MDI are well known in the art.  
They are made by the phosgenation of a mixture of  
30           30 polyamines obtained by the acid condensation of aniline  
and formaldehyde.

35           25       The manufacture of both the polyamine mixtures and  
the polyisocyanate mixtures is well known. The  
35           35 condensation of aniline with formaldehyde in the presence  
of strong acids such as hydrochloric acid gives a  
reaction product containing diaminodiphenylmethane  
together with polymethylene polyphenylene polyamines of  
40           40 higher functionality, the precise composition depending  
in known manner inter alia on the aniline/formaldehyde  
ratio. The polyisocyanates are made by phosgenation of  
45           45 the polyamine mixtures and the various proportions of  
diamines, triamines and higher polyamines give rise to  
35           35 related proportions of diisocyanates, triisocyanates and  
higher polyisocyanates. The relative proportions of  
diisocyanate, triisocyanate and higher polyisocyanates in  
50           50

5 such crude or polymeric MDI compositions determine the  
average functionality of the compositions, that is the  
average number of isocyanate groups per molecule. By  
10 5 varying the proportions of starting materials, the  
average functionality of the polysiocyanate compositions  
can be varied from little more than 2 to 3 or even  
higher. In practice, however, the average isocyanate  
15 functionality preferably ranges from 2.3-2.8. The NCO  
value of such polymeric or crude MDI is at least 30% by  
10 weight. The polymeric or crude MDI contain  
diphenylmethane diisocyanate, the remainder being  
polymethylene polyphenylene polyisocyanates of  
20 functionality greater than two together with by-products  
formed in the manufacture of such polyisocyanates by  
15 phosgenation of polyamines. Further modified variants of  
such crude or polymeric MDI may be used as well  
25 comprising carbodiimide, uretonimine, isocyanurate,  
urethane, allophanate, urea and/or biuret groups;  
especially the aforementioned uretonimine and/or  
20 carbodiimide modified ones and the urethane modified ones  
are preferred. Mixtures of polyisocyanates may be used  
30 as well.

The invention also relates to a polyol composition,  
35 25 comprised of polyols b1, b2 and b3.

Polyol b1 can be prepared by known methods. It has a  
structure of the type PO-EO, where EO is present as  
tipped EO. The EO content is from 10 to 25 % by weight.

40 30 Polyol b2 can also be prepared by known methods. It  
can have a structure of the type PO-PO/EO-EO or of the  
type PO/EO-EO. EO is present as tipped and random. The  
total EO content is from 20 to 50 % by weight, preferably  
45 from 21 to 49 %, the tipped EO content is from 10-20 % by  
weight. In the PO-PO/EO-EO type polyol, the first PO  
35 block comprises preferably from 20 to 75 % by weight of  
the PO units. Preferably the weight ratio tipped  
EO/random EO is from 1:3 to 3:1. The polyol having a  
50

5 structure of the type PO-PO/EO-EO can notably be produced according to the teaching of US 5594097. The polyol having a structure of the type -PO/EO-EO can notably be produced according to the teaching of US 4559366.

10 5 Polyol b3 is the optional polyol. It can also be prepared by known methods. It can have a structure of type PO/EO or of the type -EO (PEG). EO is present as random EO (if and when PO is present). The EO content is more than 50% by weight. Preferably it is a polyoxyethylene polyol. The functionality of these polyols is comprised between 2 and 6, preferably between 2 and 4.

20 For b1 and b2, the equivalent weight is generally comprised between 1000 and 4000, preferably 1500 and 3500; while for b3, the equivalent weight is generally comprised between 200 and 3000, preferably 300 and 2000.

25 The polyol composition comprises the various polyols according to the following proportions, expressed on the basis of the combined weights of the polyols:

20 b1 : 60-97 %, preferably 65-90 %

30 b2 : 3-40 %, preferably 10-30 %

b3 : 0-25 %, preferably 0-10 % (more preferably 3-10 %); all percentages being % by weight.

Each component b1, b2 and b3 may be comprised of mixtures.

35 Dispersed material can also be present. This is known as polymer-modified polyol, and comprise e.g. SAN or PIPA (Poly Isocyanate Poly Addition).

40 30 The polymer-modified polyols which are particularly interesting in accordance with the invention are products obtained by in situ polymerisation of styrene and/or acrylonitrile in poly(oxyethylene/oxypropylene)polyols and products obtained by in situ reaction between a polyisocyanate and an amino- or hydroxy-functional compound (such as triethanolamine) in a poly(oxyethylene/oxypropylene)polyol. The solids content (based on the total polyol weight b1+b2+b3) can vary

5 within broad limits, e.g. from 5 to 50 % by weight. Particle sizes of the dispersed polymer of less than 50 microns are preferred. Mixtures can be used as well.

10 5 Water is used as the blowing agent. Carbon dioxide may be added if needed. In the case of highly resilient water blown flexible foams, it is appropriate to use from 1.0 to 15 and preferably from 2 to 10 % by weight of water based on the weight of the total polyol component where the water can optionally be used in conjunction  
15 10 with carbon dioxide.

Other conventional ingredients (additives and/or auxiliaries) may be used in making the polyurethanes. These include catalysts, for example, tertiary amines and organic tin compounds, surfactants, cross linking or  
20 15 chain extending agents, for example, low molecular weight compounds such as diols, triols (having a molecular weight below the one of b3) and diamines, flame proofing agents, for example halogenated alkyl phosphates, fillers and pigments. Foam stabilizers, for example polysiloxane-  
25 20 polyalkylene oxide block copolymers, may be used to stabilize or regulate the cells of the foam.

30 The amount of these minor ingredients used will depend on the nature of the product required and may be varied within limits well known to a polyurethane foam technologist.  
35 25

The present invention also relates to a process for preparing a flexible polyurethane foam at an NCO index of 70-120 by reacting a polyisocyanate a); a  
40 30 polyoxyethylene-polyoxypropylene polyol b1); a polyoxyethylene-polyoxypropylene polyol b2); a polyol b3); according to ratios specified above; water c); and additives and auxiliaries known per se d).

45 These components, notably the polyols b1, b2 and b3 can be added in any order. Notably, the polyols can be  
35 35 added according to the following non-limiting possibilities:

50 Part of  $b1+b2+b3$ , then the remainder of  $b1+b2+b3$ ;

55

5 Part of b1+b2 but no b3, then the remainder of  
b1+b2 and all b3;  
Part of b1+b3 but no b2, then the remainder of  
b1+b3 and all b2;  
10 5 all of b1, then the all of b2+b3; all of b2, then  
the all of b1+b3;  
Part of b1, then the remainder of b1 together  
with the all of b2+b3;  
15 Part of b2, then the remainder of b2 together  
with the all of b1+b3;  
10 And any other possibility.

In the process of the invention, it is to be noted  
20 that one shot, prepolymer or quasi-prepolymer methods may  
thus be employed as may be appropriate for the particular  
15 type of polyurethane being made. The components of the  
polyurethane forming reaction mixture may be mixed  
25 together in any convenient manner, for example the  
individual components may be pre-blended so as to reduce  
the number of component streams to be brought together in  
20 the final mixing step. It is often convenient to have a  
two-stream system whereby one stream comprises a  
30 polyisocyanate or isocyanate-terminated prepolymer and  
the second stream comprises all the other components of  
the reaction mixture.

25 The flexible foams may be made according to  
35 techniques known in the art like the moulding or the  
slabstock technique. The foams may be used in the  
furniture and automotive industries in seating,  
cushioning and mattresses.

40 30 The flexible foams thus obtained have a free rise  
density comprised between 18 and 60 kg/m<sup>3</sup>. These foams  
show a resilience higher than 45 %.

45 The following examples illustrate the invention  
without limiting same.

35 Unless otherwise indicated, all parts are given by  
weight.

50

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Glossary

(all functionalities are nominal functionalities, equivalent weights are nominal equivalent weights, all % are % by weight and OH values are in mg KOH/g)

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Polyol A PO-EO, with EO as tipped. EO content is 15 %. Equivalent weight is 2004. Functionality is 3, OH value is 28.

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Polyol B PO-PO/EO-EO, total EO content is 21 %. Tip EO content is 15 %. Equivalent weight is 2004. Functionality is 3, OH value is 28.

20

Polyol C PO-PO/EO-EO, total EO content is 28,6 %. Tip EO content is 15 %. Equivalent weight is 2004. Functionality is 3, OH value is 28.

25

Polyol D PO/EO-EO, total EO content is 26 %. Tip EO content is 15 %. Equivalent weight is 2153. Functionality is 3, OH value is 26.

30

Polyol E PO/EO-EO, total EO content is 21 %. Tip EO content is 15 %. Equivalent weight is 1934. Functionality is 3, OH value is 29.

35

Polyol F polyoxyethylene polyol having an equivalent weight of 450, an OH value of 123 and a functionality of 3.

40

Polyol G Polymer polyol, comprising 25 % of dispersed particulate SAN material in high molecular weight polyol, similar to polyol A, but with an equivalent weight of 1600 and an OH value of 35.

45

Polyol H PO/EO-EO, total EO content is 28 %. Tip EO content is 15 %. Equivalent weight is 2004. Functionality is 3, OH value is 28. Primary hydroxyl content is 85.2

50

Polyol I PO-PO/EO-EO, total EO content is 28 %. First PO block contains 55% PO over total PO and EO. Tip EO content is 15 %. Equivalent weight is 2004. Functionality is 3, OH value is 29. Primary hydroxyl content

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- 5 is 86.7
- Isocyanate A MDI comprising 93.8 % diisocyanate 48.2 %  
of which is 2,4'-MDI and 6.2 % is oligomer  
species of higher functionality.  
10 Functionality is 2.05.
- Isocyanate B MDI comprising 87.5 % diisocyanate 46.0 %  
of which is 2,4'-MDI and 12.5 % is oligomer  
species of higher functionality.  
15 Functionality is 2.10.
- Isocyanate C Quasi-prepolymer based on MDI (81.3 %  
diisocyanate 30 % of which is 2,4'-MDI and  
18.7 % is oligomer species of higher  
20 functionality, Functionality is 2.16.) and  
polyol A. NCO value is 29.7.
- Isocyanate D MDI comprising 78.2 % diisocyanate 26.0 %  
of which is 2,4'-MDI and 21.8 % is oligomer  
species of higher functionality.  
25 Functionality is 2.19.
- D8154 Amine catalyst from Air Products  
Niax A1 Catalyst from Union Carbide  
D33LV Catalyst from Air Products  
30 DMEA Dimethylethanolamine  
DETDA diethyl toluenediamine
- Foams are produced according to the following scheme.  
Polyols, catalysts, surfactants, water are mixed prior to  
35 the addition of isocyanates. Polyol blends and isocyanates  
are mixed at 20°C during 8 seconds before foaming. Free-  
5 rise foams are made in plastic buckets of 2.5 l to 10 l.  
Moulded foams are made with a square mould of 9.1 l  
40 preheated to 45°C.
- The properties of the foam are determined according  
to the following methods and standards :
- 10 FRD (Free Rise Density);  
45 OAD (OverAll Density) (kg/cm<sup>3</sup>), and CD (Core Density)  
(kg/cm<sup>3</sup>) : ISO 845  
Compression hardness: CLD 40% (kPa) and Hysteresis Loss  
50 (%) : ISO 3386-1
- 55

5

Compression set (thickness) : Dry 75 % (%) and Humid 75 %  
(%) : ISO 1856  
Indentation Hardness :ILD 40 % (N) and Hysteresis Loss  
10 5 (%) : ISO 2439  
Resilience (%) Toyota  
Tear strength, max (N/m) : ISO 8067  
Tensile strength(kPa) and Elongation (%) : ISO 1798

15

10 The results are summarized in the following tables.  
From the last table, one will note that the specific  
polyols of the type PO/EO-EO are even better than those  
20 of the type PO-PO/EO-EO, since they provide higher foam  
stability (lower recession %) and lower free rise  
15 density, and are thus particularly designed for making  
lower density foams.

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Component	Examples											
	1	2	3	4	5	6	7	8	9	10	11	12
Polyol A	75	65	65	75	85	85	65	60	85	75	75	65
Polyol B	20	30	30	20								
Polyol C					10	10	30	35	10	20	20	30
Polyol D												
Polyol E												
Polyol F	5	5	5	5	5	5	5	5	5	5	5	5
Polyol G												
Water	6.5	6.5	6	6	5	5	6	6	5	6	7	8
B 4113	0.8	0.8	1.2	1.2	0.5	1.0	1.0	1.0	1.0	1.0	1.0	1.0
D 8154	0.7	0.7	0.6	0.6	0.7	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Niax A1	0.1	0.1	0.1	0.1		0.1	0.1	0.1	0.1	0.1	0.1	0.1
D 33 LV	0.3	0.3	0.3	0.3		0.3	0.3	0.3	0.3	0.3	0.3	0.3
DMEA					0.5							
DETDA					0.3							
Isocyanate A	80	80				75	85	85				
Isocyanate B			80	80					75	85	85	100
Isocyanate C					76							
NCO index	80	80	86	86	85	89	85.6	85.6	96	86.4	80	82.2

Component	Examples														24
	13	14	15	16	17	18	19	20	21	22	23	24	25	26	
Polyol A	65	65	65	65	85	85	67	67	55	65	55	55			55
Polyol B	30	30	30	30					30						
Polyol C					10	10	8	8							
Polyol D										10	20				
Polyol E															20
Polyol F	5	5	5	5	5	5	5	5	5	5	5	5			5
Polyol G															
Water	6	6	7	7	5	5	4	5	6.6	4	4	4			4
B 4113	1.2	1.2	1.2	1.2	1.2	1.2	0.5	0.5	1.2	0.5	0.5	0.5			0.5
D 8154	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.6	0.7	0.7	0.7			0.7
Niex A1	0.1	0.1	0.1	0.1	0.1	0.1			0.1						
D 33 LV	0.3	0.3	0.3	0.3	0.3	0.3			0.3						
DMEA							0.5	0.5		0.5	0.5	0.5			0.5
DETDA							0.3	0.3		0.3	0.3	0.3			0.3
Isocyanate A															
Isocyanate B	75	80	80	85	75	80			85						
Isocyanate C							63	76		63	63	63			63
NCO index	80	86	74	79	96	101	86	86	83.5	86	86	86			86

Properties	Examples											
	1	2	3	4	5	6	7	8	9	10	11	12
Cells	open	open	open*	Open*	open	open	open	open	open*	open*	open	open
Recession %	8	4	0	0	2	5	5	2	0	0	0	2
FRD (kg/cm <sup>3</sup> )	26.7	23.3	22	22.8	33.5	27.7	24.6	23.5	25.5	19.6	21.2	19.6
Moulding												
overall density kg/m <sup>3</sup>												
Core density (kg/m <sup>3</sup> )												
Compression hardness												
CLD 40 % (kPa)			1.7		3.25	2.8	2.8	2.7	1.7	2.3	2.2	3.2
Hysteresis (%)			34.3		35.05	34	39.3	42.7	31.35	39.5	42.4	46.5
Compression set (thick)												
Dry 75 % (%)												
Humid 75 % (%)												
Indentation hardness												
ILD 40 % (N)												
Hysteresis (%)												
Resilience (%)									55.4		48.2	
Tear strength												
Max (N/m)												
Tensile strength (kPa)												
Elongation (%)												

\* borderline

Properties	Examples											
	13	14	15	16	17	18	19	20	21	22	23	24
Cells	open* 0	open* 0	open* 0	open* 0	open* 0	open* 0	Open 0	Open 0				
Recession % FRD (kg/cm <sup>3</sup> )							39	34.5	22.8			
Moulding overall density (kg/m <sup>3</sup> )							42.9			44.2	43.9	44.8
Core density (kg/m <sup>3</sup> )	21.1	20.2	20.2	19.1	22.3	22.3	41			42.4	41.1	41.7
Compression hardness												
CLD 40 % (kPa)	1.4	1.6	1.5	1.6	1.5	1.9	3.7	4.6	2.7	4.6	5.0	4.6
Hysteresis (%)	3.0	31.9	32.4	34.5	26.1	30.4	26.9	40.6	42.9	28.7	28.4	28.4
Compression set (thick)												
Dry 75 % (%)	12.4	11.6	18.9	25.6	7	7.5	10.1			8.7	9.1	8.5
Humid 75 % (%)	25.6	36.5	49.9	53	13.3	12.5	12.8			10.6	9.4	9.4
Indentation hardness												
ILD 40 % (N)							211.8			255	264	267
Hysteresis (%)							28.2			30.9	31.7	30.7
Resilience (%)	51.5	51	50	50	56	53.5	55.4			54.6	54.9	54.2
Tear strength												
Max (N/m)	205	219	225	248	175	169	190			246	249	246
Tensile strength (kPa)	70	81	80	84	78	83	87.2			85	79	84
Elongation (%)	135	117	123	115	108	105	90			97	97	95

\* borderline

Component	Example									
	25	26	27	28	29	30	25	26	27	28
Polyol A	90	85	80	90	85	80				
Polyol H	10	15	20							
Polyol I				10	15	20				
Water	4.2	4.2	4.2	4.2	4.2	4.2				
B 4113	0.8	0.8	0.8	0.8	0.8	0.8				
Niix A1	0.1	0.1	0.1	0.1	0.1	0.1				
D 33 LV	0.8	0.8	0.8	0.8	0.8	0.8				
Isocyanate D	60	60	60	60	60	60				
NCO index	89	89	89	89	89	89				
Cells	open	open	open	open	open	open				
Recession %	22	16	5	27	20	10				
FRD (kg/cm <sup>3</sup> )	50.5	43.8	36.3	55.9	47.9	37.8				
Compression hardness										
CLD 40 % (kPa)	7.0	6.0	5.1	7.3	6.4	5.1				
Hysteresis (%)	33.9	35.7	39.6	34.1	35.0	37.7				

## Claims

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CLAIMS

1.- A polyol composition comprising :

10           5       b1) a polyoxyethylene-polyoxypropylene polyol,  
having an average nominal hydroxyl functionality of 2-6  
where the EO is present as tipped EO, the EO content  
being between 10-25 %;

15           10       b2) a polyoxyethylene-polyoxypropylene polyol,  
having an average nominal hydroxy functionality of 2-6,  
where the EO is present as tipped EO and random EO, the  
total EO content being between 20-50 %, the tipped EO  
content being between 10-20 %,

20           15       b3) a polyol, having an average nominal hydroxy  
functionality of 2-6, and comprising EO and optionally PO  
where the EO is present as random EO, the EO content  
being at least 50 %,

25           20       these polyols b1, b2 and b3 being present according  
to the following proportions, based on the combined  
weights of b1, b2 and b3, b1 : 60-97 wt %, b2 : 3-  
40 wt %, b3 : 0-25 wt %.

30           25       2.- The polyol composition according to claim 1,  
which comprises the polyols b1, b2 and b3 according to  
the following proportions : b1 : 65-90 wt %, b2 : 10-  
35       30 wt %, b3 : 0-10 wt %.

40           30       3.- The polyol composition according to claim 1 or  
2, in which in the polyoxyethylene-polyoxypropylene  
polyol b2), the weight ratio tipped EO/random EO is  
between 1:3-3:1.

45           35       4.- The polyol composition of claims 1-3, wherein  
the polyol b2) is of the -PO-PO/EO-EO type.

50           35       5.- The polyol composition of claims 1-3, wherein  
the polyol b2) is of the -PO/EO-EO type.

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5                   6.- The polyol composition of claims 1-5, wherein  
the functionality of the polyols b1, b2 and b3 is 2-4.

10                   7.- The polyol composition of claims 1-6, wherein  
5                   the polyol b3) is a polyoxyethylene polyol.

15                   8.- The polyol composition of claims 1-7, which  
comprises dispersed particles.

20                   9.- The polyol composition of claims 1-8, wherein  
10                   the equivalent weight of polyols b 1) and b 2) is 1000-  
4000 and of polyol b 3) is 200-3000.

25                   10.- Process for preparing a flexible polyurethane  
15                   foam at an NCO index of 70-120 by reacting :

20                   a) a polyisocyanate composition;  
25                   b1) a polyoxyethylene-polyoxypropylene polyol,  
having an average nominal hydroxyl functionality of 2-6  
where the EO is present as tipped EO, the EO content  
20                   being between 10-25 %;

30                   b2) a polyoxyethylene-polyoxypropylene polyol,  
having an average nominal hydroxy functionality of 2-6,  
where the EO is present as tipped EO and random EO, the  
total EO content being between 20-50 %, the tipped EO  
25                   content being between 10-20 %,   
35                   b3) a polyol, having an average nominal hydroxy  
functionality of 2-6, and comprising EO and optionally PO  
where the EO is present as random EO, the EO content  
being at least 50 %,   
40                   30                   these polyols b1, b2 and b3 being present according  
to the following proportions, based on the combined  
weights of b1, b2 and b3, b1 : 60-97 wt %, b2 : 3-  
40 wt %, b3 : 0-25 wt %;

45                   c) water; and  
35                   d) additives and auxiliaries known per se.

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- 5           11.- The process according to claim 10, in which the polyols b1, b2 and b3 are used according to the following proportions : b1 : 65-90 wt %, b2 : 10-30 wt %, b3 : 0-10 wt %.
- 10           5           12.- The process according to claim 10 or 11, in which in the polyoxyethylene-polyoxypropylene polyol b2), the weight ratio tipped EO/random EO is between 1:3-3:1.
- 15           10           13.- The process of claims 10-12, wherein the polyol b2) is of the -PO-PO/EO-EO type.
- 20           15           14.- The process composition of claims 10-13, wherein the polyol b2) is of the -PO/EO-EO type.
- 25           15           15.- The process of claims 10-14, wherein the functionality of the polyols b1, b2 and b3 is 2-4.
- 30           20           16.- The process of claims 10-15, wherein the polyol b3) is a polyoxyethylene polyol.
- 35           25           17.- The process of claims 10-16, in which the polyol comprises dispersed particles.
- 40           30           18.- The process of claims 10-17 wherein polyols b 1) and b 2) have an equivalent weight of 1000-4000 and polyol b 3) of 200-3000 and the polyisocyanate is diphenylmethane diisocyanate optionally comprising homologues thereof having an isocyanate functionality of 3 or more and modified variants thereof.
- 45           35           19.- A reaction system comprising A) a polyisocyanate and B) an isocyanate-reactive component comprising the polyol composition of claims 1-8 and water.
- 50
- 55